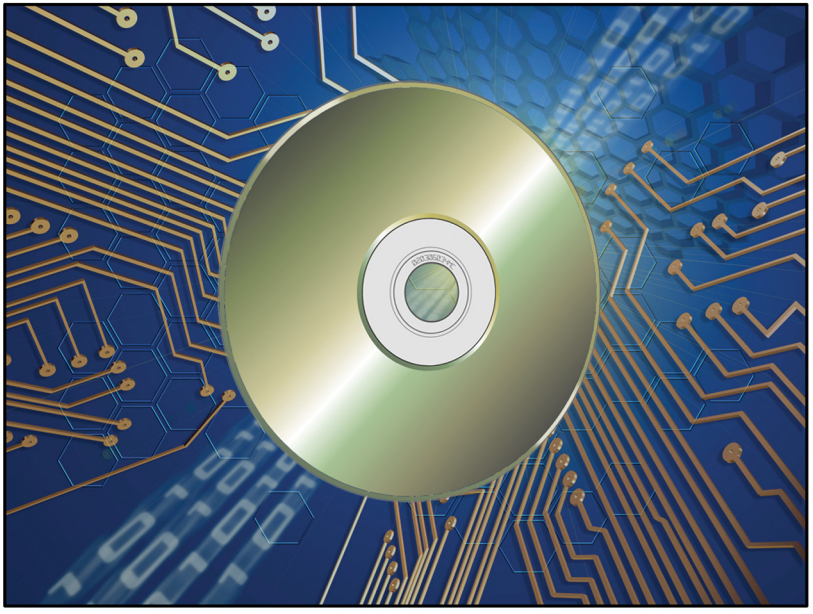
PROG for ARM® Cortex™-M processors

USER MANUAL



freescale Connect
Proven Partner

Purchase Agreement

This software and accompanying documentation are protected by United States Copyright law and also by International Treaty provisions. Any use of this software in violation of copyright law or the terms of this agreement will be prosecuted.

All the software in this package is copyrighted by P&E Microcomputer Systems, Inc. Copyright notices have been included in the software.

P&E Microcomputer Systems authorizes you to make archival copies of this software for the sole purpose of back-up and protecting your investment from loss. Under no circumstances may you copy this software or documentation for the purpose of distribution to others. Under no conditions may you remove the copyright notices from this software or documentation.

This software may be used by one person on up to two different computers, provided that the software is never used on the two computers at the same time. P&E expects that group programming projects making use of this software will purchase a copy of the software and documentation for each user in the group. Contact P&E for volume discounts and site licensing agreements.

With respect to the physical media provided within, P&E Microcomputer Systems warrants the same to be free of defects in materials and workmanship for a period of 30 days from the date of receipt. If you notify us within the warranty period, P&E Microcomputer Systems will update the defective media at no cost.

P&E Microcomputer Systems does not assume any liability for the use of this product beyond the original purchase price. In no event will P&E Microcomputer Systems be liable for additional damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use or inability to use these programs, even if P&E Microcomputer Systems has been advised of the possibility of such damage.

By installing or using this software, you agree to the terms of this agreement. If you do not agree with these terms, you should not install this software.

©2013 P&E Microcomputer Systems, Inc.

Windows is a registered trademarks of Microsoft Corporation.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. ARM is a registered trademark and Cortex is a trademark of ARM Limited. ColdFire, Kinetis, and Qorivva are registered trademarks of Freescale Semiconductor, Inc.

All other product or service names are the property of their respective owners.

P&E Microcomputer Systems, Inc.
98 Galen St.
Watertown, MA 02472
617-923-0053
http://www.pemicro.com

Manual version: 1.03
July 2013

1 OVERVIEW 1
1.1 Programming Algorithms (.ARP Files) 2
1.2 Start-Up Configuration 2
1.3 Manual Programming 2
1.4 Scripted Programming 3
1.5 Hardware Interfaces 3
1.6 Programming Utilities 3
2 PROGRAMMING ALGORITHMS 4
2.1 Algorithm File Contents 4
2.2 Algorithm Timing Considerations 6
2.3 Modiying A Programming Algorithm 6
2.4 Creating A Programming Algorithm 7
3 PROGRAMMING COMMANDS 8
3.1 BM - Blank Check Module 9
3.2 BR - Blank Check Range 9
3.3 CM - Choose Module .ARP 9
3.4 EB - Erase Byte Range 10
3.5 EM - Erase Module 10
3.6 EW - Erase Word Range 10
3.7 HE - Help 10
3.8 PB - Program Bytes 10
3.9 PM - Program Module 10
3.10 PW - Program Words 11
3.11 QU - Quit 11
3.12 RE - Reset chip 11
3.13 SM - Show Module 11
3.14 SS - Specify S-Record 11
3.15 UM - Upload Module 11
3.16 UR - Upload Range 12
3.17 VM - Verify Module 12
3.18 VR - Verify Range 12

4 START-UP CONFIGURATION 13
5 CONNECTION MANAGER 18
6 MANUAL PROGRAMMING 22
6.1 Manual Programming Procedure 22
7 SCRIPTED PROGRAMMING (CPROG for ARM® Cortex™-M processors) 24
8 HARDWARE INTERFACES 25
8.1 USB Multilink Universal 25
8.2 USB Multilink Universal FX 26
8.3 Tracelink 28
8.4 Cyclone MAX 29
9 PROGRAMMING UTILITIES 32
9.1 Serialize 32
APPENDIX A - ALGORITHM SETUP COMMANDS 33
APPENDIX B - ALGORITHM TABLE ENTRY 36

1 OVERVIEW

PROG for ARM® Cortex™-M processors (PROGACMP) is P&E's programming software for Flash/EEPROM modules that are attached to a Freescale ARM® Cortex™-M4 processor. PROGACMP talks to the processor's background debug module using one of P&E's compatible hardware interfaces. These interfaces connect a PC running XP/2000/2003/Vista/7/8 to a debug connector on the target system. This connector provides access to the debug signals of the processor chip mounted on your target system hardware board.

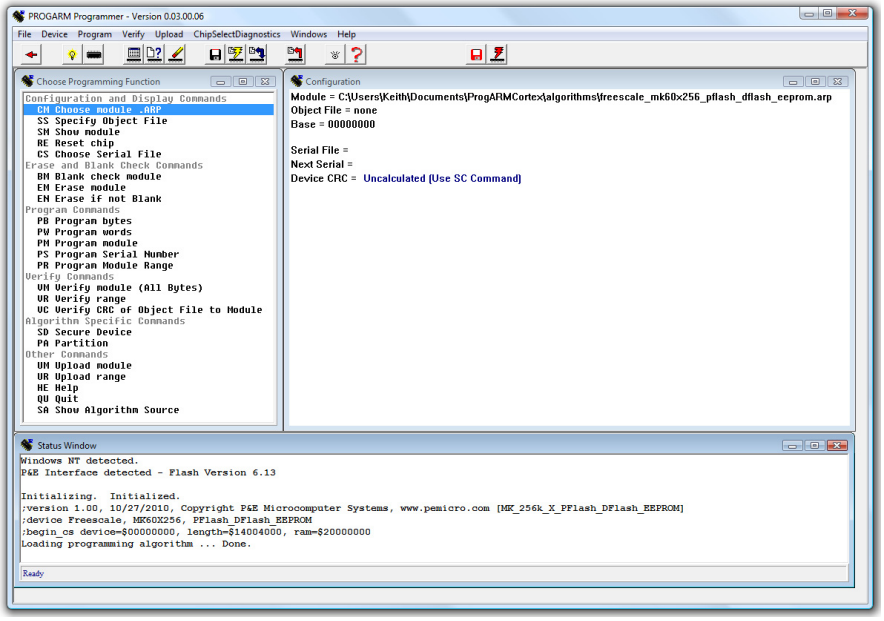


Figure 1-1: PROGACMP User Interface

As part of the programming procedure, the user will need to select a programming

algorithm that will enable the PROG for ARM Cortex-M processors software to properly manage their specific target device during programming. The user may also choose to set certain programming parameters before beginning to program. This chapter presents a brief overview of the programming procedure.

1.1 Programming Algorithms (.ARP Files)

PROG for ARM Cortex-M processors runs on the PC and provides a set of general interface functions and processor-specific user functions that are used to control the erasing, verifying, programming and viewing of modules to be programmed. These general functions are implemented for a particular target configuration and chip set by using specific Programming Algorithm (.ARP) files that the user can modify to reflect the setup of their particular target interface. PROG for ARM Cortex-M processors includes a library of these programming algorithms. For the most recent version of this library of algorithms, please visit our website, *www.pemicro.com*.

Programming algorithm files can also be modified by the user according to specific conventions. In addition, P&E can create programming algorithms upon request if you are working with a device whose corresponding algorithm is not included in the current library. Some additional information about the contents and modification of programming algorithms is included in **CHAPTER 2 – PROGRAMMING ALGORITHMS**.

1.2 Start-Up Configuration

Certain programming parameters can be adjusted when launching the PROG for ARM Cortex-M processors software by using the executable command-line to input the appropriate parameters. These may include settings related to the type of hardware interface you are using, S-record verificaton, and more, depending on your target device. A list of specific parameters with examples of their usage is included in **CHAPTER 4 – START-UP CONFIGURATION**.

1.3 Manual Programming

PROG for ARM Cortex-M processors lists commands that are available to execute. Any of the programmer's enabled features can be selected by using the mouse, the up and down arrow keys, or by typing the selection letters to the left of the selection display. Pressing ENTER or double clicking the mouse will execute the highlighted entry if it is enabled. The user will be prompted for any additional information that is required to execute the selected function. Before you can program a module from an S record file, you must select such a file. If you try to do a program module function

and you have not selected an S-record file, you will be asked to select one. A list of programming commands and their functions may be found in **CHAPTER 6 – MANUAL PROGRAMMING**.

1.4 Scripted Programming

Programming commands, in addition to being executed manually, may also be collected into script files which can be used to automate the programming process. These scripts are executed by a command-line programming application called CPROG for ARM Cortex-M processors, which is included with the PROG for ARM Cortex-M processors software. More information about scripted programming is located in **CHAPTER 7 – SCRIPTED PROGRAMMING (CPROG for ARM® Cortex™-M processors)**.

1.5 Hardware Interfaces

In addition to PROG for ARM Cortex-M processors programming procedures, this manual discusses hardware interfaces that may be used in conjuction with the PROG for ARM Cortex-M processors. For supported Freescale processors, P&E typically offers both value-oriented development solutions and more robust and versatile production solutions. You can learn about these interfaces in **CHAPTER 8 – HARDWARE INTERFACES**.

1.6 Programming Utilities

P&E also offers some no-cost programming utilities to help the user perform certain tasks. More information is available in **CHAPTER 9 – PROGRAMMING UTILITIES**.

2 PROGRAMMING ALGORITHMS

P&E's .ARP programming algortihm files define the functions necessary for PROG for ARM Cortex-M processors to program a Freescale ARM® Cortex™-M4 family processor's internal flash or connected external Flash/EEPROM. After you choose the appropriate algorithm, it will appear in the Configuration Window.

Figure 2-1: Configuration Window

2.1 Algorithm File Contents

You may view and, if necessary, modify the contents of an algorithm by opening it in any text editor. A .ARP programing algorithm file consists of four parts:

1. Comments
2. User-specified functions
3. Setup commands
4. S-records

2.1.1 Comments

Comments are usually placed in the file to identify the target system for which the .ARP file was written and what module on the target system it programs, as well as other useful information. If a specific .ARP file is selected in PROG for ARM Cortex-M processors, these comments are shown in the window at the bottom of the PC screen. Within the algorithm file a semicolon is used to designate the beginning of a comment.

2.1.2 User Specified Functions

There can be up to six user-specified functions included in a .ARP file. Each user statement in the .ARP file must have a corresponding address in same order as the table part of the S-records and an appropriate set of code. A line which defines a user specified programming function has a total of 57 characters in the form:

```
USER=uuuuuuuuuuuuuuuuuuuuuuuNppppppppppp/llllllll/
uuuuuuuu/
```

Where:

USER= is the keyword to identify the line

uuuuuuuuuuuuuuuuuuuuuuu is the 22 character string placed in the selection menu window on the PC screen. The first few characters define the menu select function and should be unique.

N is a single numeric digit between 0 and 4. If it is zero, the program will not ask for a user parameter. If it is non-zero, the user will be asked for a parameter with N hexadecimal digits. This parameter will be passed to the corresponding user routine in RAM.

pppppppppp is the 10 character prompt used to solicit the user input parameter.

/ is required for error checking.

llllllll is an 8 hex character lower bound on the user parameter.

uuuuuuuu is an 8 hex character upper bound on the user parameter.

2.1.3 Setup Commands

Setup Commands are used to initialize the target CPU when it is not possible to do so using the enable function, which must first be loaded into target RAM before execution. Setup commands appear alone on a separate line of the .ARP file starting in column one. All setup commands must appear before the first S record in the .ARP file or they will be ignored. For a list of valid Setup Commands, see **APPENDIX A - ALGORITHM SETUP COMMANDS**.

2.1.4 S-Records

Any line in the programming algorithm file starting with an "S" in column 1 is considered an S-record. S1, S2 and S3 records are allowed. S7, S8 and S9 termination records are ignored. PROG for ARM Cortex-M processors uses the address field on the first S record detected in the file as the starting address of target RAM. Each .ARP file in the library contains a programming algorithm for a particular device.

The S records are loaded into on chip RAM on the ARM® Cortex™-M4 microcontroller and provide the functions necessary to carry out the functions specified below. All other records are written to the screen when the .ARP file is selected for programming. PROG for ARM Cortex-M processors programming

algorithm files must have the DOS filename extension ".ARP" in order for PROG for ARM Cortex-M processors to find them. The files are in ASCII and are thus readable using most text editors. The S records for a .ARP file can be generated using most assemblers.

2.2 Algorithm Timing Considerations

Most current flash devices have an on-chip programming monitor. The processor passes a command to the flash device, such as Program Word, and the flash device executes this command. On all Freescale processors with On-Chip flash, and on some external flash devices, the timing is provided by the processor. In order to program the flash device according to specification, the programming software on the PC has to know how fast the target processor is running. By default, the PROG for ARM Cortex-M processors software tries to determine automatically how fast the target is running by loading a delay routine in the processor and timing how long it takes to execute. Under a multitasking environment, such as XP/2000/2003/Vista/7/8, although they are usually very accurate, these timing measurements are not always correct.

P&E addresses this by providing a command-line mechanism that allows the user to inform the PROG software how fast the target processor is running. The ensures that the timing in the algorithms is always correct. To do this, the user would include the FREQ indentifier on the executable command-line, followed by the INTERNAL clock frequency in Hertz. For instance, if your processor is a MK40X256 with a bus frequency of 20MHz, your command-line parameters should look like this:

```
PROGACMP freq 20000000
```

See **CHAPTER 4 – START-UP CONFIGURATION** for more information about how to use command-line parameters.

2.3 Modiying A Programming Algorithm

In certain situations, users may wish to modify a programming algorithm file in order to perform functions like turning off a watchdog, enabling port pins, speeding up the algorithm, etc. This can typically be accomplished by opening the algorithm in a text editor and modifying the Setup Commands. For a list of Setup Commands and their corresponding parameters, please see **APPENDIX A - ALGORITHM SETUP COMMANDS**.

2.4 Creating A Programming Algorithm

In certain situations, a user may wish to either create their own programming algorithm or make significant modifications to an existing file.

A .ARP file is a structured file which contains a table of essential system constants and routine addresses. This table is followed by the definitions of the routines. Register and memory usage conventions must be followed when your insert your own set of routines. Any routine which can not or need not be provided is given a zero (0) address in the table. The table, routines, stack and buffer reside in the CPU on chip RAM during the execution of PROG for ARM Cortex-M processors. Routines return to PROG for ARM Cortex-M processors by executing a breakpoint (BKPT) instruction.

The table contains several long word (32-bit) entries listed in an exactly specified order. For a listing of the table entries and their order, please see **APPENDIX B - ALGORITHM TABLE ENTRY** . In addition, the table is assembled at the starting address at which the on chip RAM will be configured during execution of PROG for ARM Cortex-M processors. Furthermore, the table must be the first thing assembled to insure that it is the first S record in the .ARP file.

Examples of the assembler files (.ASM files) used to produce the .ARP files for external flash are available upon request. The first part of each file is the table that generates S records. The origin or the table tells the PC program where the on chip RAM should be configured during the programming process. The choice is made in a manner that does not conflict with other things in the target system, such as the module to be programmed.

The programming routines for a particular module are loaded into the ARM® Cortex™-M4 processor's on-chip RAM for execution during erasure, programming, verification and showing of the module. The routines and associated comments for a particular module are in the form of Freescale S-records stored in the .ARP programming algorithm.

3 PROGRAMMING COMMANDS

When the user performs manual programming, commands are executed by selecting them from the Choose Programming Function Window pick list. The user may either use the up/down arrow keys or type the two-letter abbreviation for the command (listed below) on the command line to select a command. Pressing ENTER causes the selected command to execute. Commands can also be executed from the Menus or from the Button Bar. If there is any additional information needed in order to execute the command, the user will be prompted for this information in a new window. Errors caused by a command or any other responses will be presented in the Status Window.

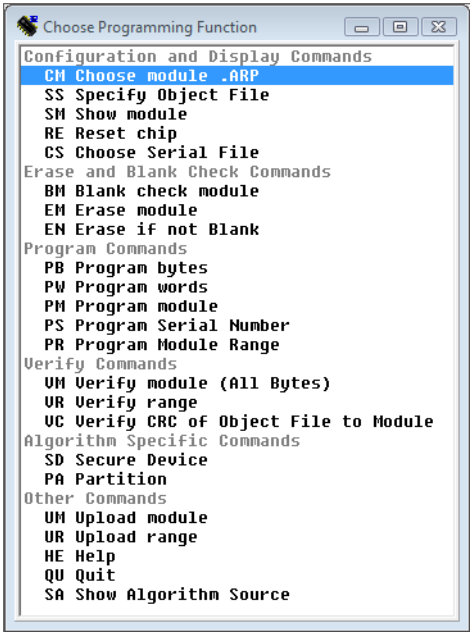


Figure 3-1: Choose Programming Fucntion Window

At any given time, or for a particular module, some of the commands may not be active. Inactive commands are indicated as such in the Choose Programming Functions Window and will not execute.

Below is a description of each of the PROG for ARM Cortex-M processors commands used in manual programming. These same commands are also used in scripted programming. For more information about scripted programming, see the **CPROG for ARM Cortex-M processors User Guide**.

3.1 BM - Blank Check Module

This command checks the entire module to see if it has been erased. If not, the address of the first non-blank location is given along with its contents.

3.2 BR - Blank Check Range

This command checks to see if a specified range of locations has been erased. The user is prompted for the starting and ending addresses. These addresses must lie within the addressing range of the module or an error will be returned. If the range is not erased, the first non-blank location is given along with its contents.

3.3 CM - Choose Module .ARP

The user is presented with a list of available .ARP files. Each .ARP file contains information on how to program a particular module. Usually, the name of the file indicates what kind of module it relates to. For example, the file Freescale_MK40X256_1x32x64k_PFlash.ARP specifies how to program the 256K PFlash block on a MK40X256 processor. Setup information and further descriptions of the module are provided in ASCII text within the module file. This information is presented in the status window when a .ARP file is selected. The user can also look at this information inside of the module itself by using any standard text editor to view the module contents.

A particular .ARP file is selected by using the arrow keys to highlight the file name and then pressing ENTER. The currently selected .ARP file is shown in the .ARP file selected window. After a .ARP file is selected, the user is prompted for the base address of the module. This address is used as the beginning address for the module during programming and verification. Certain .ARP files, such as those for external flash flash algorithms, will prompt the user for the base address of the module.

3.4 EB - Erase Byte Range

This command erases bytes in a specified range of locations. The user is prompted for the starting and ending addresses. These addresses must lie within the addressing range of the module or an error will be returned. If the range is not erased, the first non-blank location is given along with its contents.

3.5 EM - Erase Module

This command erases the entire module. If the entire Module is not erased, an error message will be returned.

3.6 EW - Erase Word Range

This command erases words in a specified range of locations. The user is prompted for the starting and ending addresses. These addresses must lie within the addressing range of the module or an error will be returned. If the range is not erased, the first non-blank location is given along with its contents.

3.7 HE - Help

Opens this PROG for ARM Cortex-M processors user manual.

3.8 PB - Program Bytes

The user is prompted for a starting address, which must be in the module. The user is then shown an address and a byte. Pressing ENTER shows the next location. The user can also enter in hex a byte to be programmed into the current location. In addition, the symbols +, -, or = may be appended to the value being written. They correspond respectively to increase the address (default), decrease the address, and hold the address constant. Failure to program a location, entering an invalid hex value or exceeding the address range of the module will exit the program bytes window. If a location fails to program, an error message will be returned.

3.9 PM - Program Module

For this command to work, the user must have previously selected an S-record file. The S-records are then checked to see if they all reside in the module to be programmed. If not, the user is asked if they want to continue. If the answer is yes, only those S-record addresses which lie in the module are programmed. If a location cannot be programmed, an error message will be returned.

3.10 PW - Program Words

The user is prompted for a starting address, which must be in the module. The user is then shown an address and a word. Pressing ENTER shows the next location. The user can also enter in hex a word to be programmed into the current location. In addition, the symbols +, -, or = may be appended to the value being written. They correspond respectively to: increase the address (default), decrease the address, and hold the address constant. Failure to program a location, entering an invalid hex value or exceeding the address range of the module will exit the program words window. If a location fails to program, an error message will be returned.

3.11 QU - Quit

Terminates PROG for ARM Cortex-M processors and returns to Windows.

3.12 RE - Reset chip

This causes a hardware reset to the ARM® Cortex™-M4 microcontroller. This command can be used to recover from errors which cause the programmer not to be able to talk to the processor through the background debug mode.

3.13 SM - Show Module

The user is prompted for a starting address. If this address is not in the module and error is given. A window is opened which shows the contents of memory as hex bytes and ASCII characters if printable. Non-printing characters are shown as periods ("."). This window stays on the screen until the user presses ESCAPE.

3.14 SS - Specify S-Record

If the file is not found, an error message is given. The currently selected file is shown in the S19 file selected window. The programmer accepts S1, S2, and S3 records. All other file records are treated as comments. If the user does not specify a file name extension, a default of .S19 is used.

3.15 UM - Upload Module

The user is asked for a filename into which to upload S-records. The default filename extension is set to .S19 if none is specified by the user. S-records for the entire module are then written to the specified file.

3.16 UR - Upload Range

The user is prompted for a starting address, which must be in the module. Next, the user is asked for an ending address, which must also be in the module. The user is then asked for a filename into which to upload S-records. The default filename extension is set to .S19 if none is specified by the user. S-records are then written to the specified file.

3.17 VM - Verify Module

For this command to work, the user must have previously selected an S-record file. The S-records are then checked to see if they all reside in the module to be programmed. If not, the user is asked if they want to continue. If the answer is yes, only those S-record addresses which lie in the module are verified. If a location cannot be verified, an error message will be returned which indicates the address, the contents of that address, and the contents specified in the S-record file.

3.18 VR - Verify Range

For this command to work, the user must have previously selected an S-record file. The user is prompted for a starting address, which must be in the module. Next, the user is asked for an ending address, which must also be in the module. S-record addresses which lie in the module are verified. If a location cannot be verified, an error message will be returned which indicates the address, the contents of that address, and the contents specified in the S-record file.

In addition, there is one function that is allowed to be unique to the module being programmed. The selection menu name and the length of up to one hexadecimal parameter may be specified in a supporting .ARP file.

4 START-UP CONFIGURATION

The PROG for ARM Cortex-M processors software may be started in a way that enables certain optional parameters, which can assist the programming process. To set these command-line parameters, highlight the Windows Icon for the PROG for ARM Cortex-M processors executable, right-click, and select “Properties” from the pop-up File Menu. The “General” Properties tab should open by default. There are several parameters that you may then include on the command line. A description of each is listed below, followed by specific examples of how these parameters are used.

Syntax:

```
PROGACMP [bdm_speed n] [v] [interface=x] [port=y]
```

Where:

Optional parameters are in brackets [ ]. The parameters are described as follows:

[bdm_speed n] This option allows the user to set the BDM shift clock speed of P&E's BDM interfaces. This integer value may be used to determine the speed of communications according to the following equations:

Cyclone : (50000000/(2*N+5)) Hz

USB Multilink Universal : (1000000/(N+1)) Hz

USB Multilink Universal FX : (25000000/(N+1)) Hz

Tracelink : (50000000/(2*N+5)) Hz

[v] If the optional parameter v is specified as either *V* or *v*, then the range of S-records is not verified during the programming or verification process. This can help speed up these functions.

[interface=x] where *x* is one of the following: (See examples section)

USBMULTILINK (supports Multilink Universal, Multilink Universal FX, and OSJtag)

CYCLONE

TRACELINK

[port=y] Where the value of y is one of the following (see the showports command-line parameter for a list of connected hardware; always specify the "interface" type as well):

USBx — Where x = 1,2,3, or 4. Represents an enumeration number for each piece of hardware starting at 1. Useful if trying to connect to a Cyclone, Tracelink, or Multilink product. If only one piece of hardware is connected, it will always enumerate as USB1.

An example to select the first Multilink found is:

INTERFACE=USBMULTILINK PORT=USB1

#.#.#.# — Ethernet IP address #.#.#.#. Each # symbol represents a decimal number between 0 and 255. Valid for Cyclone and Tracelink interfaces.

Connection is via Ethernet.

INTERFACE=CYCLONE PORT=10.0.1.223

NAME — Some products, such as the Cyclone and Tracelink, support assigning a name to the unit, such as "Joe's Max". The Cyclone may be referred to by it's assigned name. If there

are any spaces in the name, the whole parameter should be enclosed in double quotes (this is a Windows requirement, not a P&E requirement).

Examples:

INTERFACE=CYCLONE PORT=MyCyclone99

INTERFACE=CYCLONE "PORT=Joe's Max"

UNIQUEID — USB Multilink products all have a unique serial number assigned to them, such as PE5650030. The Multilink may be referred to this number. This is useful in the case where multiple units are connected to the same PC.

Examples:

INTERFACE=USBMULTILINK PORT=PE5650030

COMx — Where x = 1,2,3, or 4. Represents a COM port number. Valid for Cyclone interfaces.

To connect to a Cyclone on COM1 :

INTERFACE=CYCLONE PORT=COM1

x — Where x = 1,2,3, or 4. Represents a parallel port number

To select a parallel interface on Parallel Port #1 :

INTERFACE=PARALLEL PORT=1

PCIx	Where x = 1,2,3, or 4. Represents a BDM Lightning card number. (Note: this is a legacy product)
	To select a parallel cable on BDM Lightning #1 :
	INTERFACE=PARALLEL PORT=PCI1

Example 1

CPROGACMP C:\ENGINE.CFG Interface=USBMULTILINK Port=USB1

Opens CPROG for ARM Cortex-M processors with the following options:

- Run the C:\ENGINE.CFG script
- Interface is USB Multilink Universal, first cable detected.

Example 2

CPROGACMP C:\ENGINE.CFG Interface=CYCLONEMAX Port=209.61.110.251

Opens CPROG for ARM Cortex-M processors with the following options:

- Run the C:\ENGINE.CFG script
- Interface is Cyclone MAX via the Ethernet Port with an IP address of 209.61.110.251

Example 3

CPROGACMP C:\ENGINE.CFG Interface=USBMULTILINK Port=USB1 bdm_speed 0

Opens CPROG for ARM Cortex-M processors with the following options:

- Run the C:\ENGINE.CFG script
- Interface is USB Multilink Universal, first cable detected.
- BDM shift clock speed set to 1,000,000 Hz. [bdm_speed n] = USB Multilink Universal: (1,000,000/(N+1)) Hz. For n = 0, BDM shift clock speed for USB Multilink

Universal = (1,000,000/(0+1)) Hz = 1,000,000 Hz

5 CONNECTION MANAGER

Before programming your device, you will need to connect to your target using a hadware interface. Interface options for PROG for ARM Cortex-M processors are discussed in **Section 8 - HARDWARE INTERFACES**.

Once you have physically connected your PC to your target using the hardware interface, and the appropriate drivers are installed, the following Connection Manager dialog will appear:

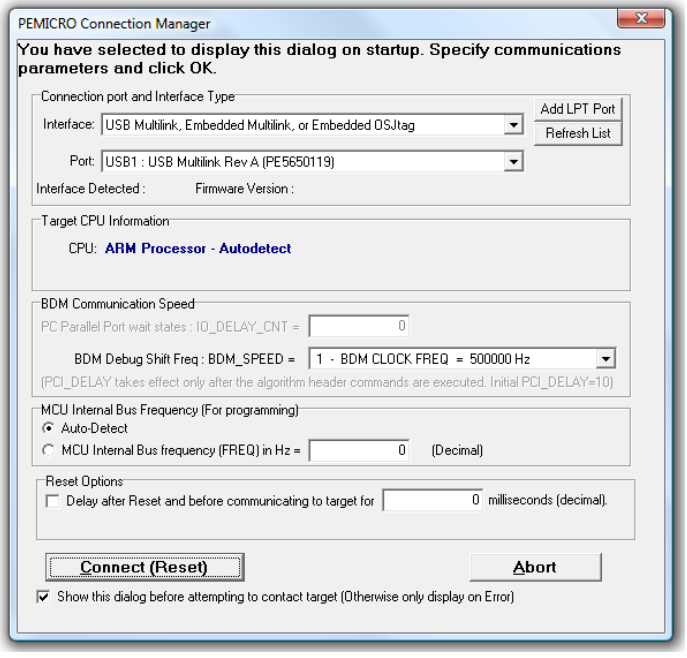

PEMICRO Connection Manager
You have selected to display this dialog on startup. Specify communications parameters and click OK.
Connection port and Interface Type
Interface: USB Multilink, Embedded Multilink, or Embedded OSJtag
Add LPT Port
Refresh List
Port: USB1 : USB Multilink Rev A (PE5650119)
Interface Detected :
Firmware Version :
Target CPU Information
CPU: ARM Processor - Autodetect
BDM Communication Speed
PC Parallel Port wait states : IO_DELAY_CNT =
0
BDM Debug Shift Freq : BDM_SPEED =
1 - BDM CLOCK FREQ = 500000 Hz
(PCI_DELAY takes effect only after the algorithm header commands are executed. Initial PCI_DELAY=10)
MCU Internal Bus Frequency (For programming)
Auto-Detect
MCU Internal Bus frequency (FREQ) in Hz =
0
(Decimal)
Reset Options
Delay after Reset and before communicating to target for
0
milliseconds (decimal).
Connect (Reset)
Abort
Show this dialog before attempting to contact target (Otherwise only display on Error)

Figure 5-1: Connection Manager Dialog

The Connection Manger allows you to choose the interface that you wish to use and

configure the connection.

Use the Interface drop-down menu to choose the type of interface that you plan to use.

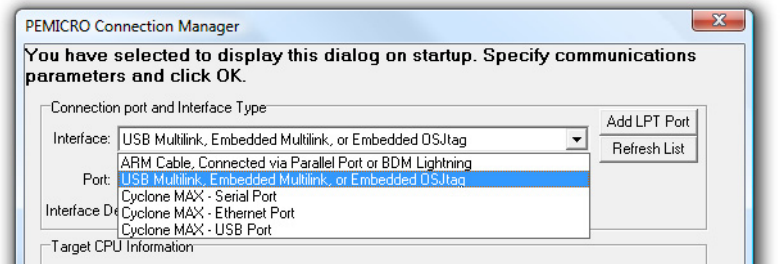

PEMICRO Connection Manager
You have selected to display this dialog on startup. Specify communications parameters and click OK.
Connection port and Interface Type
Interface:
USB Multilink, Embedded Multilink, or Embedded OSJtag
Add LPT Port
Refresh List
Port:
ARM Cable, Connected via Parallel Port or BDM Lightning
USB Multilink, Embedded Multilink, or Embedded OSJtag
Cyclone MAX - Serial Port
Cyclone MAX - Ethernet Port
Cyclone MAX - USB Port
Target CPU Information

Figure 5-2: Connection Manager - Select Interface

Then select the interface from those available, which are listed in the Port drop-down list. The Refresh List button to the right may be used to update the list of available interfaces.

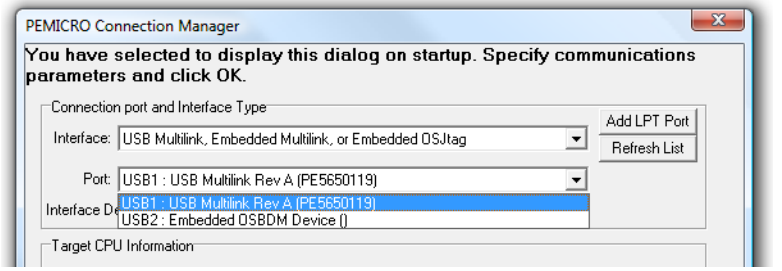

PEMICRO Connection Manager
You have selected to display this dialog on startup. Specify communications parameters and click OK.
Connection port and Interface Type
Interface:
USB Multilink, Embedded Multilink, or Embedded OSJtag
Add LPT Port
Refresh List
Port:
USB1 : USB Multilink Rev A (PE5650119)
USB1 : USB Multilink Rev A (PE5650119)
USB2 : Embedded OSBDM Device ()
Target CPU Information

Figure 5-3: Connection Manager - Select Port

The Add LPT Port button to the right allows you to manually specify a parallel port address. This allows you to use virtual or PCI-based parallel ports which are not specified in the computer's BIOS. The following dialog will appear, which you can use to configure the port:

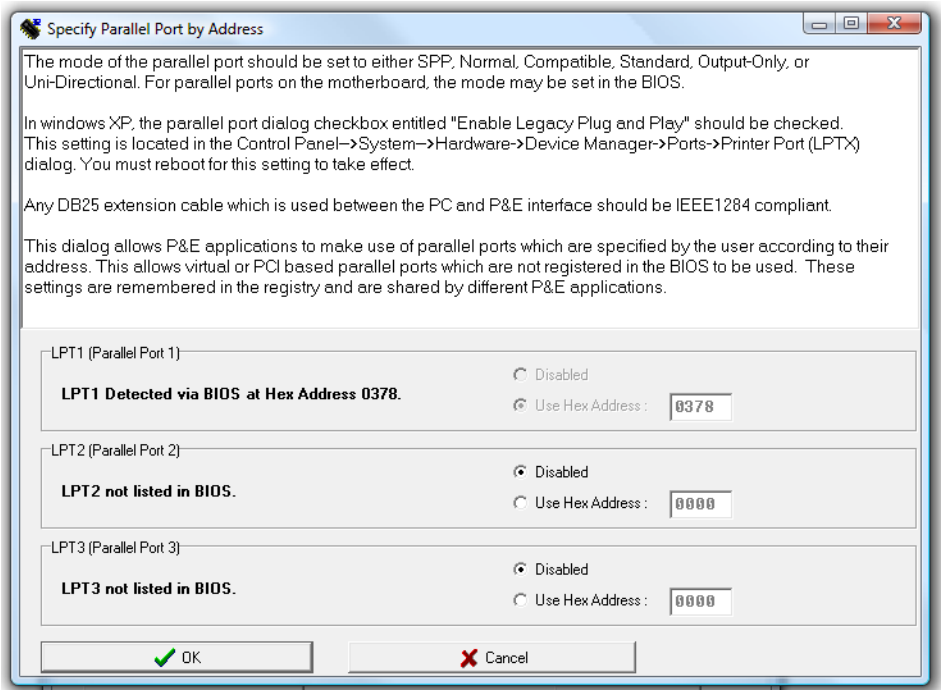

Specify Parallel Port by Address
The mode of the parallel port should be set to either SPP, Normal, Compatible, Standard, Output-Only, or Uni-Directional. For parallel ports on the motherboard, the mode may be set in the BIOS.
In windows XP, the parallel port dialog checkbox entitled "Enable Legacy Plug and Play" should be checked. This setting is located in the Control Panel->System->Hardware->Device Manager->Ports->Printer Port (LPTX) dialog. You must reboot for this setting to take effect.
Any DB25 extension cable which is used between the PC and P&E interface should be IEEE1284 compliant.
This dialog allows P&E applications to make use of parallel ports which are specified by the user according to their address. This allows virtual or PCI based parallel ports which are not registered in the BIOS to be used. These settings are remembered in the registry and are shared by different P&E applications.
LPT1 (Parallel Port 1)
LPT1 Detected via BIOS at Hex Address 0378.
Disabled
Use Hex Address :
0378
LPT2 (Parallel Port 2)
LPT2 not listed in BIOS.
Disabled
Use Hex Address :
0000
LPT3 (Parallel Port 3)
LPT3 not listed in BIOS.
Disabled
Use Hex Address :
0000
OK
Cancel

Figure 5-4: Connection Manager - Add LPT Port

Beneath that section, the Connection Manager, the BDM Debug Shift Frequency can be selected from the drop-down list in the BDM Communication Speed section.

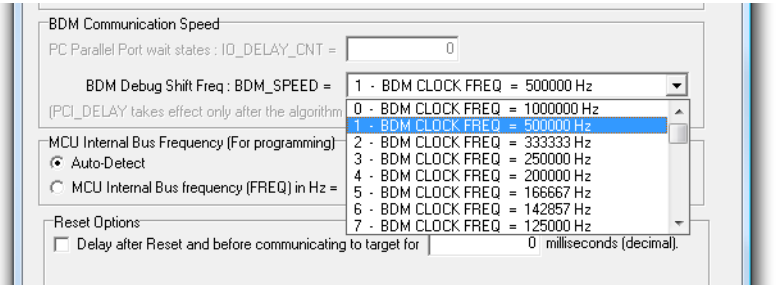

BDM Communication Speed
PC Parallel Port wait states : IO_DELAY_CNT =
0
BDM Debug Shift Freq : BDM_SPEED =
1 - BDM CLOCK FREQ = 500000 Hz
(PCI_DELAY takes effect only after the algorithm
0 - BDM CLOCK FREQ = 1000000 Hz
1 - BDM CLOCK FREQ = 500000 Hz
2 - BDM CLOCK FREQ = 333333 Hz
3 - BDM CLOCK FREQ = 250000 Hz
4 - BDM CLOCK FREQ = 200000 Hz
5 - BDM CLOCK FREQ = 166667 Hz
6 - BDM CLOCK FREQ = 142857 Hz
7 - BDM CLOCK FREQ = 125000 Hz
MCU Internal Bus Frequency (For programming)
Auto-Detect
MCU Internal Bus frequency (FREQ) in Hz =
Reset Options
Delay after Reset and before communicating to target for
0
milliseconds (decimal).

Figure 5-5: Connection Manager - BDM Shift Freq.

You may also choose to auto-detect or manually specifcy the MCU bus frequency in

the MCU Internal Bus Frequency section.

Below that, you have the option of setting a reset delay.

Once you have made your selections, Click the Connect (Reset) button to connect to the target. If you are successful, you will be prompted to choose a programming algorithm for your target using the following browse window:

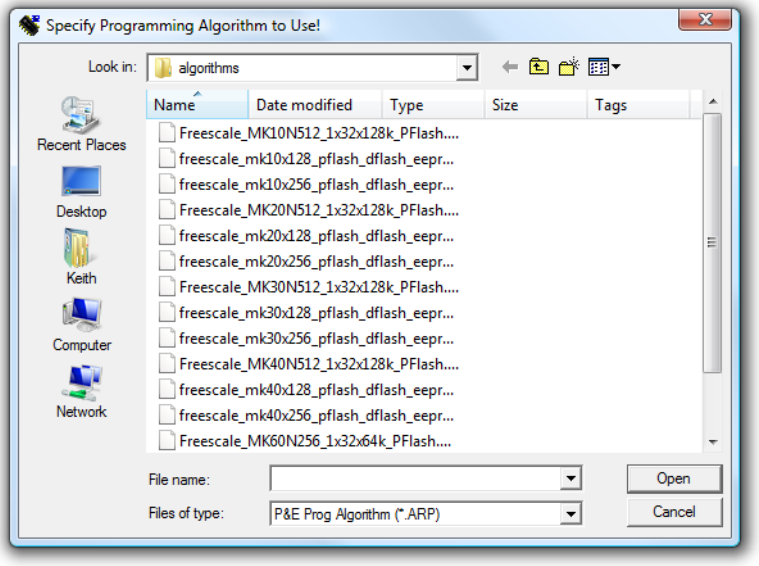


Figure 5-6: Select Algorithm

Once you have selected the appropriate algorithm, you are ready to begin programming.

6 MANUAL PROGRAMMING

The Choose Programming Function Window (see **Figure 3-1**) lists commands that are available to execute. Any of the programmer's enabled features can be selected using the mouse, the up and down arrow keys, or by typing the two-letter command abbreviations that appear to the left of the list of programming functions into the Status Window. The Status Window also displays any error messages that might result from the commands that you perform.

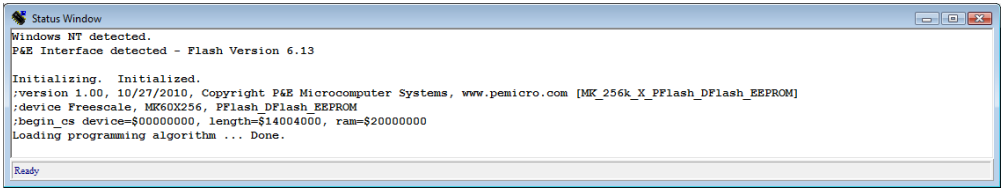

Status Window
Windows NT detected.
P&E Interface detected - Flash Version 6.13
Initializing. Initialized.
:version 1.00, 10/27/2010, Copyright P&E Microcomputer Systems, www.pemicro.com [MK_256k_X_PFlash_DFlash_EEPROM]
:device Freescale, MK60X256, PFlash_DFlash_EEPROM
:begin_cs device=$00000000, length=$14004000, ram=$20000000
Loading programming algorithm ... Done.
Ready

Figure 6-1: Status Window

Pressing ENTER or double clicking the mouse in the Choose Programming Function Window will execute the highlighted entry if it is enabled. The user will be prompted for any additional information that is required to execute the selected function. Before you can program a module from an S record file, you must select such a file. If you try to execute a program module function and you have not selected a file, you will be asked to select one.

6.1 Manual Programming Procedure

Here is the procedure for performing manual programming:

1. Before turning on your power supply, check that the target power supply is on and the interface cable is connected to your target board. Be sure to apply proper target voltage before programming the flash. If you lose contact with your target board at any time during the procedure, you may double-click the "RE" command (Reset) to begin again.

2. Using the PROG for ARM Cortex-M processors software, choose the programming algorithm by selecting the appropriate .ARP file. Double clicking the "CM" (Choose Module) command will allow you to select the algorithm you wish to use.
3. After you select the .ARP file, you may be asked for the base address. This is the address at which you would like to program the code. Enter the appropriate base address.
4. a) Use the "EM" (Erase Module) command to erase the module at that location. The process of erasing the module will vary according to the size of the flash, but should take no longer than 30 seconds. If this procedure seems to be taking much longer than 30 seconds, then the computer is probably not getting a proper response from the board. If this is the case:

   b) Check the jumper setting on your target board, as well as the programming voltage.
5. Some programming algorithms have a special command, such as "BE," for block erase. If you are unable to double-click the "EM" (Erase Module) command, try using the "BE" (Block Erase) command. Some commands are hidden and you may need to use the scroll bar to scroll down to these commands.
6. You may check to see whether or not the module has been erased by double-clicking the "BM" command (Blank Check Module). If the flash is not properly erased then this command will give you an error message. You may also check the contents of the memory locations by double-clicking the "SM" (Show Module) command. If the flash has been erased properly then all the memory locations will display "FF".
7. Now use the "SS" command (Specify S Record) to load the object file (.S19), which you should have generated previously by using a compiler or an assembler. This command will ask for the name of the .S19 file.
8. Now you ready to program the flash. Double click the "PM" command (Program Module) to begin the programming process.
9. In order to check the results, use the "SM" command (Show Module) with the appropriate base address to view the contents of the flash. You should see that the flash has been correctly programmed. You may also double-click the “VM” command (Verify Module) to verify that all the bytes of the flash are correctly programmed.

7 SCRIPTED PROGRAMMING (CPROG for ARM® Cortex™-M processors)

Programming commands, in addition to be executed manually, may also be collected into script files which can be used to automate the programming process. These scripts are executed by a command-line programming application called CPROG for ARM Cortex-M processors, which is included with the PROG for ARM Cortex-M processors software. When you run the CPROGACMP.EXE application, it will look for the *prog.cfg* script file and automatically execute the commands in that file.

For complete instructions on how to configure and execute the CPROG for ARM Cortex-M processors scripted programmer, please see the **CPROGACMP User Guide**.

8 HARDWARE INTERFACES

P&E's Multilink Universal, Multilink Universal FX, Tracelink, Cyclone MAX, and Cyclone for ARM devices are compatible hardware interfaces for use with PROG for ARM Cortex-M processors. The USB Multilink Universal and USB Multilink Universal FX are development tools that communicate via USB and will enable you to debug your code and program it onto your target. The Cyclone MAX is a more versatile and robust development tool that communicates via Ethernet, USB, or Serial Port, and includes advanced features and production programming capabilities, as well as Ethernet support.

Below is a review of their features and intended usage..

8.1 USB Multilink Universal

The USB Multilink Universal offers an affordable and compact solution for your development needs, and allows debugging and programming to be accomplished simply and efficiently. Those doing rapid development will find the USB Multilink Universal easy to use and fully capable of fast-paced debugging and programming.

Figure 8-2: P&E's Multilink Universal

8.1.1 Key Features

- Programming and debugging capabilities
- Compact and lightweight
- Communication via high-speed USB 2.0
- Supported by P&E software, Freescale's CodeWarrior, and other third-party software

8.1.2 Product Features & Implementation

P&E's USB Multilink Universal interface connects your target to your PC and allows the PC access to the debug mode on Freescale's Kinetis®, ColdFire® V1/ColdFire+ V1, ColdFire V2-4, Qorivva® MPC55xx/56xx, DSC, HC(S)12(X), HCS08 and RS08 microcontrollers. It connects between a USB port on a Windows 2000/XP/2003/Vista/7/8 machine and a standard BDM or JTAG connector on the target.

By using the USB Multilink Universal interface, the user can take advantage of the background debug mode to halt normal processor execution and use a PC to control the processor. The user can then directly control the target's execution, read/write registers and memory values, debug code on the processor, and program internal or external FLASH memory devices. The Multilink Universal enables you to debug, program, and test your code on your board.

8.1.3 Software

The USB Multilink Universal interface works with Codewarrior, as well as P&E's flash programmer, PROGACMP.

8.2 USB Multilink Universal FX

The USB Multilink Universal FX offers a very high-speed development solution that is still affordable, compact, and allows debugging and programming to be accomplished simply and efficiently. As with the USB Multilink Universal, those doing rapid development will find the much speedier USB Multilink Universal FX easy to use and fully capable of fast-paced debugging and programming.

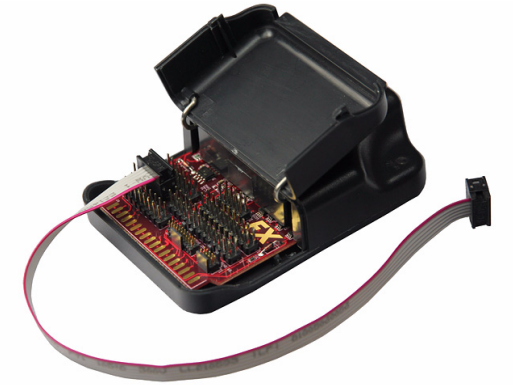


Figure 8-3: P&E's Multilink Universal FX

8.2.1 Key Features

- Extremely fast download speeds (up to 10X faster than Multilink Universal or equivalent)
- Programming and debugging capabilities
- Compact and lightweight
- Communication via high-speed USB 2.0
- Can provide power to target
- Supported by P&E software, Freescale's CodeWarrior, and other third-party software
- Supports certain legacy Freescale devices

8.2.2 Product Features & Implementation

P&E's USB Multilink Universal FX interface connects your target to your PC and allows the PC access to the debug mode on Freescale's Kinetis®, ColdFire® V1/ ColdFire+ V1, ColdFire V2-4, Qorivva® MPC55xx/56xx, DSC, HC(S)12(X), HCS08, RS08, HC16, and 683xx microcontrollers. It connects between a USB port on a Windows 2000/XP/2003/Vista/7/8 machine and a standard BDM or JTAG connector on the target.

By using the USB Multilink Universal FX interface, the user can take advantage of the background debug mode to halt normal processor execution and use a PC to control the processor. The user can then directly control the target's execution, read/write

registers and memory values, debug code on the processor, and program internal or external FLASH memory devices. The Multilink Universal enables you to debug, program, and test your code on your board.

8.2.3 Software

The USB Multilink Universal FX interface works with Freescale's CodeWarrior, as well as P&E's flash programmer, PROG for ARM Cortex-M processors.

8.3 Tracelink

P&E's Tracelink is an affordable, high-speed development interface which can capture up to 128MB of external trace on Freescale Kinetis and ColdFire V2-4 microcontrollers. The Tracelink communicates to the processor through a ribbon cable connection from the Tracelink to the debug header of the target board. By simply flipping open the plastic case of the Tracelink, the ribbon cable can be changed to match the desired Freescale processor. Ribbon cables for the supported MCU families are conveniently included.

Figure 8-4: P&E's Tracelink

8.3.1 Key Features

- External trace capture with port speeds up to 250MHz
- 128MB of trace storage
- Ethernet or High-Speed USB 2.0 communications
- Can provide power to target

- Fast performance
- Multi-voltage support for targets ranging from 1.8 to 5 Volts
- I/O line clamping for added protection
- Includes ribbon cables for all supported Freescale MCUs
- Supported by Freescale's CodeWarrior

8.3.2 Product Features & Implementation

The Tracelink connects to a host Windows PC via USB or Ethernet. Standard run control operations such as control of processor execution (run, step, breakpoint), and read/write of registers and memory are fully supported. This also includes flash programming support for both internal and external FLASH memory devices.

The main feature of the Tracelink is the ability to capture real-time trace information from the target processor. This is invaluable for debugging applications where traditional step/breakpoint methods are simply impractical. In many applications, it is not possible to halt the target processor without causing the overall system to fail. Software bugs that are difficult to reproduce and occur infrequently are usually extremely time-consuming to debug using traditional methods. The Tracelink removes these limitations, allowing the developer to spend more time finding and fixing bugs, which ultimately shortens development cycles and time to market.

8.3.3 Software

The Tracelink's trace capture ability is supported by recent versions of Freescale's CodeWarrior software.

8.4 Cyclone MAX

The Cyclone MAX is a more complete solution designed for both development and production. The Cyclone MAX features multiple communications interfaces (including USB, Ethernet, and Serial), stand-alone programming functionality, high speed data transfer, a status LCD, and many other advanced capabilities.

Figure 8-5: P&E's Cyclone MAX

8.4.1 Key Features

- Advanced programming and debugging capabilities, including:
- PC-Controlled and User-Controlled Stand-Alone Operation
- Interactive Programming via Host PC
- In-Circuit Debugging, Programming, and Testing
- Compatible with Freescale's ColdFire® V2-4, Qorivva® MPC55xx/56xx, MAC7xxx, and Kinetis® microcontroller families
- Communication via USB, Serial, and Ethernet Ports
- Multiple image storage
- LCD screen menu interface
- Supported by P&E software and Freescale's CodeWarrior

8.4.2 Product Features & Implementation

P&E's Cyclone MAX is an extremely flexible tool designed for debugging, testing, and in-circuit flash programming of Freescale's ColdFire® V2-4, Qorivva® MPC55xx/56xx, MAC7xxx, and Kinetis® microcontrollers. The Cyclone MAX connects your target to the PC via USB, Ethernet, or Serial Port and enables you to debug your code, program, and test it on your board. After development is complete the Cyclone MAX can be used as a production tool on your manufacturing floor.

For production, the Cyclone MAX may be operated interactively via Windows-based programming applications as well as under batch or .dll commands from a PC. Once loaded with data by a PC it can be disconnected and operated manually in a stand-alone mode via the LCD menu and control buttons. The Cyclone MAX has over 3Mbytes of non-volatile memory, which allows the on-board storage of multiple

programming images. When connected to a PC for programming or loading it can communicate via the ethernet, USB, or serial interfaces.

8.4.3 Software

The Cyclone MAX comes with intuitive configuration software and interactive programming software, as well as easy to use automated control software. The Cyclone MAX also functions as a full-featured debug interface, and is supported by Freescale's CodeWarrior as well as development software from P&E.

P&E's Cyclone MAX is also available bundled with additional software as part of various Development Packages. In addition to the Cyclone MAX, these Development Packages include in-circuit debugging software, flash programming software, a Windows IDE, and register file editor.

9 PROGRAMMING UTILITIES

The following no-cost programming utilities are available on P&E's website. www.pemicro.com, by navigating to Support -> Documentation & Downloads -> Utilities.

9.1 Serialize

The Serialize utility allows the generation of a .SER serial number description file. This graphical utility sets up a serial number which will count according to the bounds set by the user. The .SER file can be called by the PROG flash programmer to program a serial number into the target.

More information on how to use the Serialize utility can be found on P&E's website at: www.pemicro.com/blog/post.cfm/expert-s-corner-programming-serial-numbers-into-flash.

APPENDIX A - ALGORITHM SETUP COMMANDS

Setup Commands are commands that each appear on separate lines of a .ARP programming algorithm file, starting in column one. They are used to initialize the target CPU when it is not possible to do so using the enable function, which must first be loaded into target ram before execution. All setup commands must appear before the first S record in the .ARP file or they will be ignored.

The setup commands are:

REQUIRES_PROG_VERSION=x.xx/

Sometimes algorithms will require features to be built into the P&E flash programmer itself. If the algorithm requires a minimum version number of the programmer, use this command. The interactive programmer will give the user a warning if the programmer version is not greater than or equal to the version referenced in this command. The commandline programmer will halt with error 14.

NO_ON_CHIP_RAM

This command has 14 characters and tells the programmer not to perform any action to turn on the on chip ram. You must provide RAM to run the calibration routines and load your .ARP file S records. If not deactivated by this command, the on chip RAM is turned on after all other setup commands are executed. On chip RAM is automatically enabled in most processor in order to load the programming algorithm. If your processor has on chip ram and it is turned on automatically, use this command without any writes to chip select. If your processor has no on_chip RAM, use this command and follow it with either WRITE_BYTE, WRITE_WORD or WRITE_LONG in order to turn on chip selects to enable external RAM. The RAM should be turned on at the location where the S records in the .CFP file start.

NO_TIMING_TEST

This command has 14 characters and tells the programmer not to evaluate the target processor speed during the initialization process. Instead, both timing constants are set to 1. This option is only used when programming timing functions are not needed.

WRITE_LONG=llllllll/aaaaaaaa/

This command has 29 characters. It writes the hex long llllllll to the hex address aaaaaaaa in the current space. This command is most often used to enable the chip

selects to allow the CPU to see the flash at address 0. By default the debugger assumes the flash is on CSBOOT. You may also do all sorts of system configuration with these command.

WRITE_WORD=wwww/aaaaaaaa/

This command has 25 characters. It writes the hex word wwww to the hex address aaaaaaaa in the current space. This command is most often used to enable the chip selects to allow the CPU to see the flash at address 0. By default the debugger assumes the flash is on CSBOOT. You may also do all sorts of system configuration with these command.

WRITE_BYTE=bb/aaaaaaaa/

This command has 23 characters. It writes the hex byte bb to the hex address aaaaaaaa in the current space. This command is most often used to enable the chip selects to allow the CPU to see the flash at address 0. By default the debugger assumes the flash is on CSBOOT. You may also do all sorts of system configuration with these command.

BOUNDARY_MASK=mmmmmmmm/

This command has 23 characters. It indicates to the programmer that when buffering data down to the target, the data may not cross certain boundaries. If a value of $FFFFFF80 was used, this would indicate to the programmer that only 128 byte sections may be programming at once (aligned on 128-byte boundaries). This does not mean that the whole 128 bytes need to be programmed, only that the flash programmer will split the data up to be programmed in chunks which never cross a certain boundary. This is very useful for paged memory, or to adhere to block programming requirements of certain motorola flash.

BLOCKING_MASK=mmmmmmmm/

This command has 23 characters. First it tells the programmer that only full blocks of data can be programmed into the device and that blocks must occur on a block boundary. The mask mmmmmmmm is used to select those address lines which occur within a block. For example, blocks of 8 bytes would have a mask of 00000007. The buffer provided in the target must in size be an integral multiple of the blocking size in bytes.

BLANK_MODULE_ONLY

This command has 17 characters. It indicates to the programmer that if a blank byte

address or blank word address is provided they can only be used to enable a blank module command.

NO_BASE_ADDRESS

or

NO_BASE_ADDRESS=bbbbbbbb/

The 15 character command version tells the prog software to use a base address of 0 and not to ask the user to enter one. The 25 character version is the same except it sets the base address to bbbbbbbb.

ADDR_RANGE=aaaaaaaa/bbbbbbbb/

Normally the valid flash range is set by the module_length constant in the algorithm which the programmer then uses to decide how to display memory in the code window. If not all memory between module_address and module_address+module_length is valid, this command can be used to override the default functionality and describe to the programmer what is valid memory which should be displayed and changed. Note that these addresses are relative to the base address of the flash. aaaaaaaa is the start address relative to the base address and bbbbbbbb is the end address relative to the base address.

APPENDIX B - ALGORITHM TABLE ENTRY

Users who wish to make significant modifications to a programming algorithm may need to modify the table entries in their assembly (.ASM) file. Table entries provide information to the PROG software, including what functions are in the algorithm and where they are located. Each table entry consists of 32 bits and must be in the following order:

Stack Address

Address of the stack during routine execution. The stack is initialized each time one of the user-supplied routines is called.

Buffer Address

Address of the buffer used to transfer data from the PC to the target. This is data to be placed into the module.

Buffer Length

Length of available buffer space in bytes. The buffer should be at least 4,096 bytes long in order to accommodate the largest possible S record.

Module Address

The physical address of the beginning of the module to be programmed or erased.

Module Length

Length of the module to be programmed in bytes.

Blank Bytes Address

The address of a routine to check a block of bytes to see if they are erased. R1 contains the starting address and R2 contains the number of bytes to check. Checking is done on a byte by byte basis. If R2<>0 on return then an error occurred at word address R1-1. R2 = 0.

Blank Words Address

The address of a routine to check a block of words to see if they are erased. R1 contains the starting address and R2 contains the number of bytes to check. Checking is done on a word by word basis. If R2<>0 on return then an error occurred at word address R1-2.R2 = 0.

Erase Bytes Address

The address of a routine to erase a block of bytes. R1 contains the starting address and R2 contains the number of bytes to erase. Erasing is done on a byte

by byte basis. R2 = 0.

Erase Long Address

The address of a routine to erase a block of longs. R1 contains the starting address and R2 contains the number of bytes to erase. Erasing is done on a word by word basis. If R2<>0 on return an erase error occurred. R2 = 0.

Erade Module Address

The address of a routine which erases the entire module. R1 contains the starting address to be erased, R2 contains the length in bytes. Returning to PROGACMP with R2 non zero indicates an error.

Program Bytes Address

The address of a routine which programs a block of bytes residing in the buffer. R2 contains the length of the block in bytes. R1 contains the starting address at which they are to be programmed. R3 contains the address of the buffer. Returning with R2 non zero indicates an error.

Program Words Address

The address of a routine which programs a block of bytes residing in the buffer. R2 contains the length of the block in bytes. R1 contains the starting address at which they are to be programmed. R3 contains the address of the buffer. Returning with R2 non zero indicates an error.

On Volts Address

The address of a routine which turns on the voltages necessary to program/erase the module. This address must be 0 form PROG for ARM Cortex-M processors.

Off Volts Address

The address of a routine which turns off the voltages necessary to program/erase the module. This address must be 0 form PROG for ARM Cortex-M processors.

Enable Address

The address of a routine which sets up and enable the module at startup and after each command is executed. Returning with R2 non zero indicates an error.

Disable Address

The address of a routine which shuts down the module. This address must be 0 form PROG for ARM Cortex-M processors.

Before Read Address

The address of a routine which sets up the module to do a read. R1 contains the

address to be read.

After Read Address

The address of a routine which takes the module out of read mode.

User Function Address

This is an optional user function. It is created with a USER = statement in the .ARP file and a corresponding address as an extra address in the table. On entry, R2 is the module length, R1 is the module address, R4 is the user parameter if any, and R3 is the buffer address. If on return R2<>0 an error occurred.